

Student Learning Experience with an Industry Certification Course at University

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Abstract

This is an analysis of the computer generated feedback from an industry certification course, as taught as part of a university unit. A method for extracting useful information from the available course evaluation data is proposed, and the method is shown to be effective and reasonable. Conclusions for the particular unit are drawn. In particular it is shown that the unit was successful in giving a large cohort of students a good learning experience and that there is a high degree of correlation between student enjoyment and the professionalism of the instructor.

Keywords: Industry Certification, multiple choice

1 Introduction

An unresolved tension exists between how university units are traditionally assessed and the aim of industry certification courses. Industry requires graduates to be competent, which essentially translates into a coarse-grained pass/fail unit grade, with the focus on all students who pass having a minimum level of competence. On the other hand, universities typically try to stretch students and finely grade their performance, usually with the focus on how the better performing students are developing. Clearly, both approaches have their strengths and advocates of one can easily criticize the weaknesses of the other. However, it is important for universities to ensure that their least successful graduates have the skills expected of them by society. I believe that industry certification courses have an important role to play in universities, in the short term perhaps to address this particular issue, but in the longer term the teaching approach adopted by these courses has much to recommend it as a model for the mass delivery of well designed teaching material.

The Faculty of IT at UTS runs a regional academy in the Cisco Networking Academy Program (CNAP - see references). Although called the Networking Academy Program, it now offers courses in Java, UNIX, etc. However, this paper is concerned with the results for one particular unit, the 6 credit point Networking 1 unit which

used material and assessment tools from Cisco's Semester 1 curriculum (version 2.1.2) and ran March - June 2002. The material from Cisco Semesters 1 through 4 form the basis for certification as a CCNA (Cisco Certified Network Associate), which is an essential prerequisite for any career in networking nowadays.

Essentially, the main conditions that Cisco place on institutions which wish to use their material are that if any part of a semester is used, all of that semester must be taught, but the institution is free to add any extra material. Also all instructors must be trained in teaching the material and have passed the on-line exam in it! A challenge to those of us who thought we had finished with exams.

In this paper I first discuss some issues to do with the teaching of the unit, then explain the format of the student feedback and analyze some of the results, then present some conclusions.

2 Teaching issues

This unit is taught to both undergraduates, and to graduates who did not do much, if any, computer networking in their first degree. It establishes a degree of practical proficiency and knowledge in networking on which subsequent units build. The approach is not theoretical, and even students who have already done a more traditional university networking unit can benefit from doing the unit, as it generally fills in some gaps in their understanding

The material is covered at a fairly fast pace in one semester of 12 teaching weeks. The teaching is laboratory based, with students assigned to a particular lab class for the whole semester; with a maximum of 30 students per class (set by the number of PCs in our labs), with 20 classes and a total of 508 students this time. There are no lectures or tutorials outside the lab class, so the 3 hours/week in the lab is the extent of the face-to-face teaching. We assume that the students need to spend at least another 3 hours/week on their own in reviewing the last week and preparing for the next week's lesson. Cisco Semesters 1 through 4 can also be taught in schools, and also, at the other end of the scale, at UTS for graduates in computing, however the time taken differs, typically 70 hours per Cisco semester at school and 24 hours per semester for graduate networking students (i.e. two Cisco semesters are covered in one semester in a single 6 credit point unit with 4 hours per week contact time). The next few paragraphs briefly describe the assessment components.

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On-line forum: to complement the hands on, face-to-face teaching, there is also some on-line support in the form of a discussion forum. This is now becoming quite the norm in UTS units. However, it was originally introduced in Networking 1 to facilitate communications to all the students, since they were never all together in one place, and, also, because the unit was always seen as a very practical based unit providing a grounding in the skills and knowledge of a network engineer; and one aspect of the work of a network engineer is using on-line forums to solve networking problems. The use of on-line support for the teaching of the unit was seen as a natural way to develop skills in the use of this medium, as well as providing on-line support. It is clear some exposure is necessary. Some students initially resent using such a tool, until they discover its usefulness, others confuse it with on-line chat. We use the Caucus conferencing system (see references).

Instructors moderate the discussions, but once properly going they become a powerful tool for students to clarify things and help one another, with really very little input needed from the instructors. This is a way to let students benefit from the old adage: 'the best way to learn is to teach'.

Use of the on-line discussion tool is assessed. To remove many possible sources of confusion and irritation, the student's contribution ironically is only assessed as a hard copy of their on-line contributions, to ensure there is a permanent record of what they want marked and of their instructor's responses. This is a minor assessment component.

Journal: another minor assessment component is in the use of a log book or journal, meant both for taking notes of experiments and for reflections on how and what they are learning. Again, this is seen as an essential tool for a network engineer and as a useful tool for a student (perhaps in the future it may be seen as essential for students too?).

Exams: a major identifier of this type of industry certification seems to be the use of multiple choice exams. Such tests have well known advantages in terms of ensuring test coverage of the entire material. If not well designed, they also have the well known disadvantage of only testing superficial knowledge and encouraging students to take a 'surface' approach to learning, see RAMSDEN 1992. A strength of the Cisco scheme is that there is a multiple choice test at the end of every chapter (roughly every week as taught in this unit). This not only demonstrates student progress, but also gives a not inconsiderable motivation to study every week when some marks are given for the tests. A weakness of the Cisco scheme is that the end test is a subset of all the chapter test questions. My impression is that skilled and experienced teachers can convince most students to try and understand the material and use the multiple choice chapter tests as a test of understanding, but sometimes students will just try and remember the questions and answers. With a good memory this can be a successful strategy to pass the unit, but means that the student may not be successful working in the field. To compensate for

the weaknesses of the multiple choice exams we have now introduced an additional written exam.

The multiple choice exam result is scaled, so that 80% becomes 50%, the average mark required for a pass in the unit. Assuming the students are not surface learners, this ensures they need a good understanding of the whole syllabus in order to pass.

Skills test: the remaining assessment component is a time limited skills test in which a group of students attempt to set up a small network. This is interesting in that students can fail either because they cannot do the task, or for poor groupwork organization. It may seem strange in a university environment to have a test which deliberately puts students under time pressure, but it is seen as a fair simulation of a realistic work scenario. It is also seen by the students as a challenge which they enjoy completing.

The assessment scenario is not set by Cisco, rather Cisco provides us with a set of materials and tools which we are free to adapt and supplement to suit our teaching and our students' learning. We have chosen to use the Cisco exams for assessment, but added extra assessment components of our own. There is a lot of material to be covered, so we have chosen not to add any more material to the syllabus.

3 Student feedback

In order for a student to graduate from the unit an on-line feedback form must be completed. The form is composed of 20 questions which are answered on-line by the student using a Likert scale from 1 to 5 (Disagree \diamond Agree), see the questionnaire in table 1.

The results are compiled for each lab and returned immediately, but unfortunately we do not get the full statistical information and obviously instructors do not get to see individual forms. In the summary information available to instructors we get only the mean, minimum and maximum for each question, and also we know the numbers of students in our lab class. This immediate feedback encourages the instructor to reflect on their teaching, however I recommend that the results should be organized and put into context if an individual instructor is expected to make much sense of them. As coordinator for the unit I got to see the feedback for all 20 labs and so I get some sense of context.

I have grouped the questions from table 1 into the areas shown in table 2, and my expectation is that the means for questions in the same area in the same class will be similar, but some means will also be similar across different lab classes. Hence if e.g. area *b* is significantly different for some lab class we need to be cautious about results from that lab. Given that we have no standard deviation information, it is problematic how we define 'similar' and 'significantly different'. I propose that if, after discarding the lowest and highest means, the remaining means lie within a 1 point range they are 'similar', if outside a 1.5 point range they are 'significantly different'.

1	The instructor was adequately prepared to teach this course.
2	Analogies and real-life experiences of the instructor added value to the course.
3	Presentations were clear and easy to understand.
4	Answers to questions were provided in a timely manner
5	Class participation was enhanced through effective use of questions.
6	The class was interesting and enjoyable.
7	"Best Practices" and good teaching strategies were modeled during the training.
8	Grouping strategies were utilized effectively.
9	Class members felt comfortable approaching the instructor with questions/ideas.
10	The order of course topics aided my learning.
	The course schedule allowed me to complete the stated course objectives.
12	The activities and labs helped me to achieve the stated course objectives.
13	The lesson assessment tools helped me evaluate my knowledge of the lesson.
14	Group work aided my learning.
15	Overall, the course materials were of high quality.
16	The classroom and the laboratory provided a comfortable learning environment.

Table 1 the student on-line feedback questionnaire.

	Area	Questions	Expect same as other classes?
a	instructor	1, 3, 4, 5, 6, 7, 9	×
b	unit design	10, 11, 12, 15	✓
c	group work	8, 14	✓
	not grouped	2	×
	not grouped	13, 16	✓

Table 2 question groupings

I have not grouped question 2 since it is a property of the instructor which is not within my remit to address, and items 13 and 16 are isolated questions which refer specifically to Cisco's design of their on-line tests (Q 13) and university resourcing issues (Q 16). I have included Q 6 in area a, as my expectation is that a good instructor (i.e. high marks for other questions in area a) will correlate with students enjoying the class.

4 Analysis of results

The 'unit design' area range of means was from 3.52 to 4.43 (i.e. 'similar'), whilst the 'instructor' area ranged from 2.86 to 4.59 (i.e. 'significantly different'). (N.B. these results give the remaining minimum of minimums and maximum of maximums, for all questions in the area, after first discarding the lowest and highest mean values). It would appear that the results are reasonable. We can convert the numerical values back to a value judgment according to the scale: 1 - <1.5 = very poor, 1.5 - <2.5 = poor, 2.5 - <3.5 = average, 3.5 - <4.5 = good, 4.5 - 5 = very good. Hence the 'unit design' can be considered good.

Group work: in this area the range of means was from 3.08 to 4.25 (i.e. average to good, and neither 'similar' nor 'significantly different'), however the questions are actually asking different things. The range for Q 8 is from 3.08 to 4.17 (not 'similar'), whilst that for Q 14 is from 3.53 to 4.21 (good and 'similar'). Q 8 (Grouping strategies were utilized effectively), although to do with group work, is perhaps a comment on the instructor's performance. Hence this analysis identified that I wrongly classified an entry, i.e. that Q 8 should not be grouped in the same area as Q 14, but possibly in the area 'instructor'. This gives some confidence in that applying the rules picked up a doubtful case, however I have not included or reclassified Q 8 in the 'instructor' area as I am not sure about this question.

Q13, Q16: As a final test of the results, Q 13 and Q 16 are not related, but should be 'similar' across all classes. The range for Q 13 (The lesson assessment tools helped me evaluate my knowledge of the lesson) is 3.48 to 4.3, whilst for Q 16 (The classroom and the laboratory provided a comfortable learning environment) it is 3.53 to 4.5, both 'similar' as expected and both thought of as good by the students.

Comparison to university surveys: the university has its own course evaluation mechanisms. One important component is a similar form to the Cisco on-line evaluation. This also uses a 5 point Likert scale. However only one item (out of 8) seems similar to any question of Table 1, and that is 'My learning experiences in this subject were interesting and thought provoking'. The mean for this is 3.8 and SD 0.9, compared to an overall mean over all classes for the on-line Q 6 'The class was interesting and enjoyable' of 3.79, hence the student feedback results can be taken as repeatable. Comparing the university student feedback results for the unit with the overall results for the faculty, this unit achieved higher means in all items except 'I received constructive feedback when needed'. This was a particular problem of the Cisco on-line tests, where we decided against telling students which questions they got wrong in case it led to some of them concentrating on the questions, rather than on understanding the subject. Instead we used the test analysis to note where the class in general had a problem with a particular question and gave general feedback to the whole class. This issue has been somewhat addressed in the next version of the course (semester 1 version 2.1.3) where on completion of a test each student gets a set of links to areas where the test results show they

might need to do some more work, but it does not highlight specific mistakes.

Instructor: we can now continue with some degree of confidence in the on-line feedback survey results. In figure 1 the instructor attributes, as measured by responses to Qs 1, 3, 4, 5, 7 and 9, are plotted on the y axis against the class mean for Q 6 (The class was interesting and enjoyable) on the x axis. The results for a particular class can be identified as they fall on a vertical line. Note that the origin is not on the graph as no point falls below 2.5 on either axis, so we have exaggerated the scatter. As can be seen, Q 9 (Class members felt comfortable approaching the instructor with questions/ideas) is consistently ranked at the top end of student satisfaction with their instructor, whilst either Q 3 (Presentations were clear and easy to understand), Q 4 (Answers to questions were provided in a timely manner), or Q 7 ("Best Practices" and good teaching strategies were modeled during the training) are mostly at the bottom. However, it is also clear that all the attributes are related to how interesting and enjoyable the student found the class.

I asked a small sample of students after the course to rank the instructor attributes of table 1. They ranked Q 3 'Presentations were clear and easy to understand' and Q 1 'The instructor was adequately prepared to teach this course' as most important. I have extracted these from figure 1 and shown them in figure 2 for clarity. They can be represented as a straight line, hence demonstrating that instructors' teaching skills and professionalism are directly related to the students' enjoyment of the unit. Extrapolating back it would appear that the slope is not quite 1, since at the lower end the students' enjoyment lags the instructors' abilities (i.e. students would consider a unit 'very poor' for a 'poor' instructor), whilst at the upper end a 'very good' instructor results in a 'very good' student learning experience.

5 Conclusions

The procedure to evaluate results does correctly identify those elements of the survey which should be the same across all classes, and show that other elements can vary between classes.

The unit design was found by the students in all classes to be good. The performance of the instructors as perceived by the students varied between classes, as is only to be expected; they range from average to very good. A straight line relationship is suggested as best fit to the data, especially between students finding 'The class was interesting and enjoyable' and the instructor ensuring that 'Presentations were clear and easy to understand' and 'The instructor was adequately prepared to teach this course'. Hence it is clear that the instructors' professionalism is related to how well the students perceive the unit. This result shows that good teaching skills are important for the successful delivery of a unit based on this industry certification course, despite trying to ensure consistent delivery of material across all classes. To be fair to Cisco, they never pretended otherwise and go to considerable lengths to ensure

instructors are properly trained in 'best practices' before they can teach using this material. This is consistent with one of my aims as unit coordinator: that instructors be free to develop their own teaching style.

The best parts of the unit are its hands on nature (my opinion - not asked in the survey) and the high quality of the material (in most classes the highest mean in the area 'unit design'). Given the difficulty of keeping material up-to-date and relevant in a fast changing area such as networking, this alone is a powerful argument for incorporating such industry based courses in university units. The worst part of the unit is the nature of the multiple choice test, especially the reuse of chapter test questions in the final on-line exam (again my opinion). The survey results did not show up any unit design problems, but did identify instructors who need more support. This feedback is immediately available to instructors, so it does give them the opportunity to reflect on their performance. I believe it would aid instructors to assimilate the information contained in the feedback survey if the results were organized and put into some context (e.g. the mean for all classes and the minimum expected). The university student feedback results show that (apart from the one question discussed already) the unit consistently achieved higher means than the faculty average. Although the differences to the faculty means are all within 1 SD, so individually they are not significant, the trend clearly shows that this way of teaching works better, as far as the students are concerned, than more traditional teaching approaches.

It has been shown that teaching in these industry certification courses is not a mechanical exercise, but one where the students' perception of the unit depends critically on the teaching skills and standards of their instructor. And that the material and unit design are perceived as good by the students.

6 References

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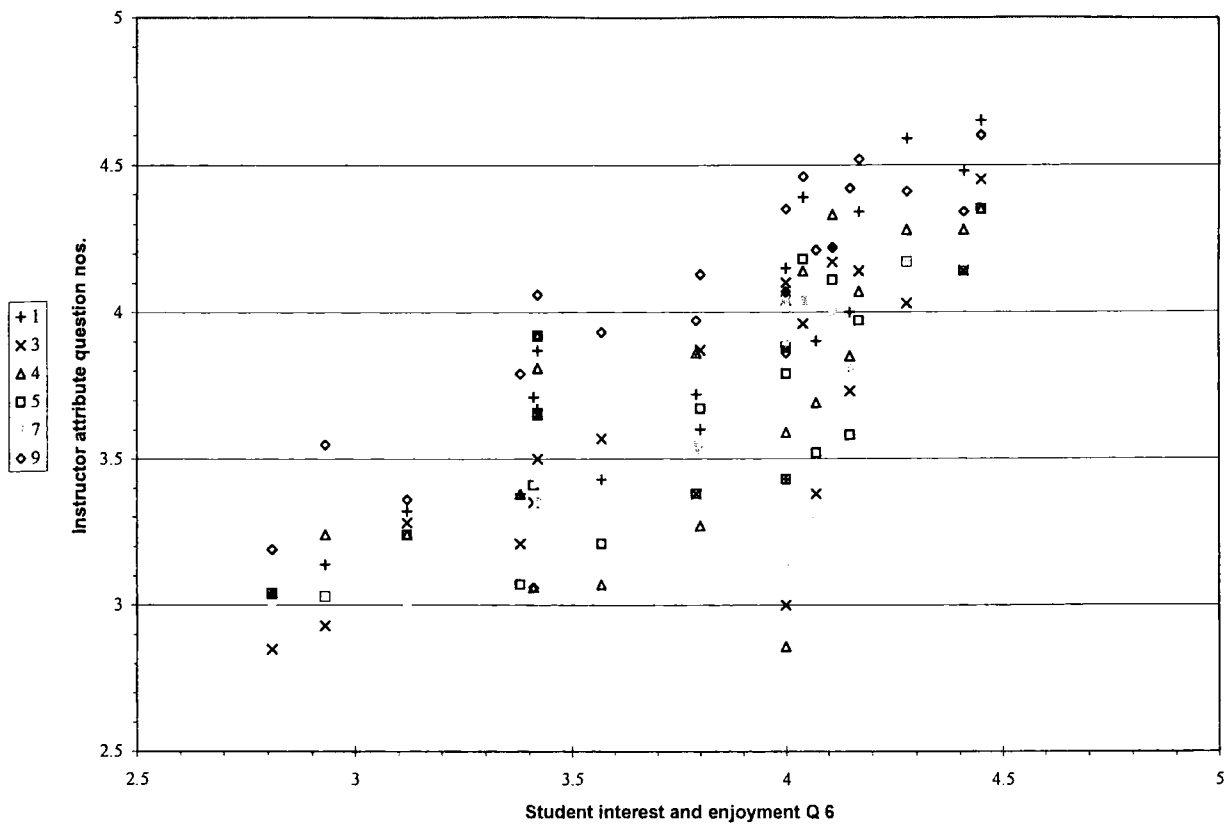


Figure 1 Student interest v. instructor attributes

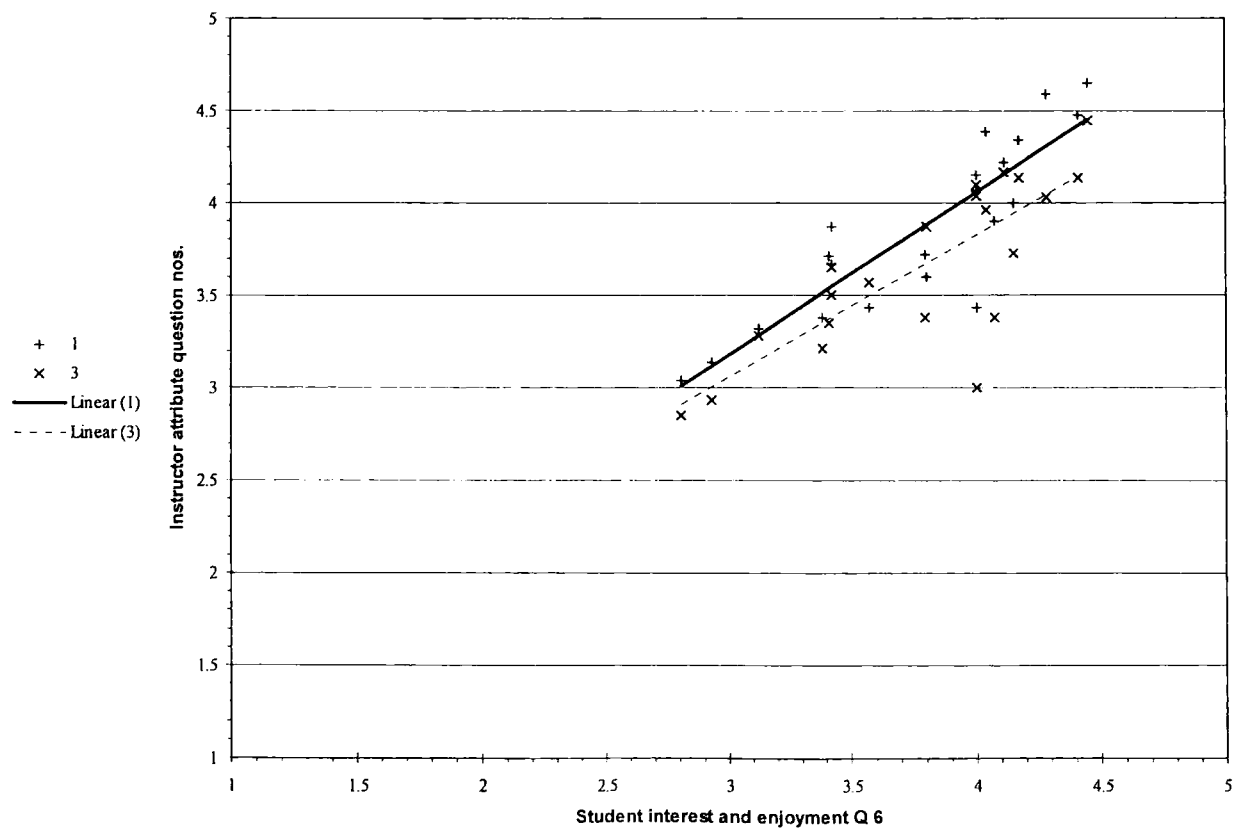


Figure 2 Student interest v. instructor attributes Q 1 and Q 3

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Foreword

Welcome to the fifth Australasian Computer Education Conference held in Adelaide, in February 2003, as part of the Australasian Computer Science Week. This conference series provides a forum for educators from all areas of computing to come together and share their experiences, ideas, and research about computing education.

An internationally distributed Call for Papers elicited 47 submissions. Each paper was double blind refereed by at least three referees. Of these 47 submissions, 34 papers (72%) were accepted for presentation.

We are grateful to the members of the program committee and all of the additional referees who have done an excellent job. Their names are listed overleaf. Without their effort and support, this conference would not have been possible.

This fifth conference is the first in the series to be part of the Australasian Computer Science Week. We are grateful for the invitation to participate in the week, and for the hard work done by that organising committee.

Tony Greening,
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ACE 2003 Program Chairs
February, 2003